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SECURITY

AD-A202 357

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unc	1b RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for the Public Release and Sale. Distribution Unlimited
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) End of Contract Report	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Nathan S. Lewis Caltech; 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) M.S. 127-72 California Institute of Technology Pasadena, California 91125	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Office of Naval Research; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N00014-85-K-0805, Mod/Amend: P00001
8c. ADDRESS (City, State, and ZIP Code) Attention: Code 413 800 N. Quincy Street Arlington, VA 22217	10 SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)
End of Contract Report from Contract N00014-85-K-0805, Mod/Amend P00001

12 PERSONAL AUTHOR(S) Heben, M.J., Kumar, A., Lewis, N. S., Penner, R. M. and Zheng, C.

13a TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
End of Contract	FROM Sept 85 TO Aug 88	1988, November 5	2

16. SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

DTIC ELECTE NOV 17 1988 S D H

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) / 22c OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete — SECURITY CLASSIFICATION OF THIS PAGE

End of Contract Report for ONR Contract N00014-85-K-0805, mod/amend: P00001

Indium Phosphide   Methyl hydroxide

Most of our efforts during the past contract period were focused on elucidation of the properties of InP semiconductor/liquid interfaces. Our interest in InP is primarily due to its potential for use in the next generation of high speed electronic devices. We have performed detailed studies of the properties of stable, nonaqueous-based n-InP/liquid contacts with a variety of redox couples.[1] Measurements of the current-voltage behavior of n-InP/MeOH based junctions confirm that charge transfer within this system can be extremely responsive to the electrochemical potential of the contacting phase. This behavior contrasts with the predicted, and observed, behavior for III-V based semiconductor/metal Schottky barrier systems. A full kinetic analysis of the n-InP/dimethyl-ferrocene$^{+/0}$-CH_3OH interface demonstrated that the deviation between theoretical prediction and actual experiment is not due merely to an artifact of the lower density of states in the liquid, but instead arises from a difference in surface potential between the liquid and metal contacts. This implies that restrictions on interface performance predicted by the unified defect model, and other models that postulate intrinsic limitations on the output properties of InP junctions, can be experimentally avoided with proper choice of redox couple and electrolyte. This work has possible implications with regard to techniques for surface passivities of InP devices and with respect to fabrication of improved Schottky barrier systems based in InP.

During the last year of our ONR contract period we initiated scanning tunneling microscopy studies of the electrode/electrolyte interface.[2] This work was motivated by the apparent lack of available techniques for the in situ investigation of electrode surface geometric and electronic structure. It is desirable to perform such investigations in electrochemical environments that contain electroactive redox species. We have developed STM tip preparation schemes[3] and a microscope[4] that have enabled us to image, on an atomic scale, highly ordered pyrolytic graphite (HOPG) surfaces which were in contact with aqueous 1 M NaCl solutions containing 0.1 M $K_3Fe(CN)_6$ and 0.1 M $K_4Fe(CN)_6$. These results suggest that solution species are sterically hindered from entering the tunneling gap and do not participate in electron transfer reactions. This advance should allow us to perform several unique experiments of electrochemical interest.

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